

# Purpose of ACAT:

## Analytica COG Analysis Tool

To enable rapid analysis of the uncertainties in the Cost of Generation (COG) spreadsheet, including:

- Range sensitivity analysis
- Monte Carlo simulation, to estimate probability distributions over LCOE, and evaluate an importance analysis
- For one or several generating technologies.

# How it works

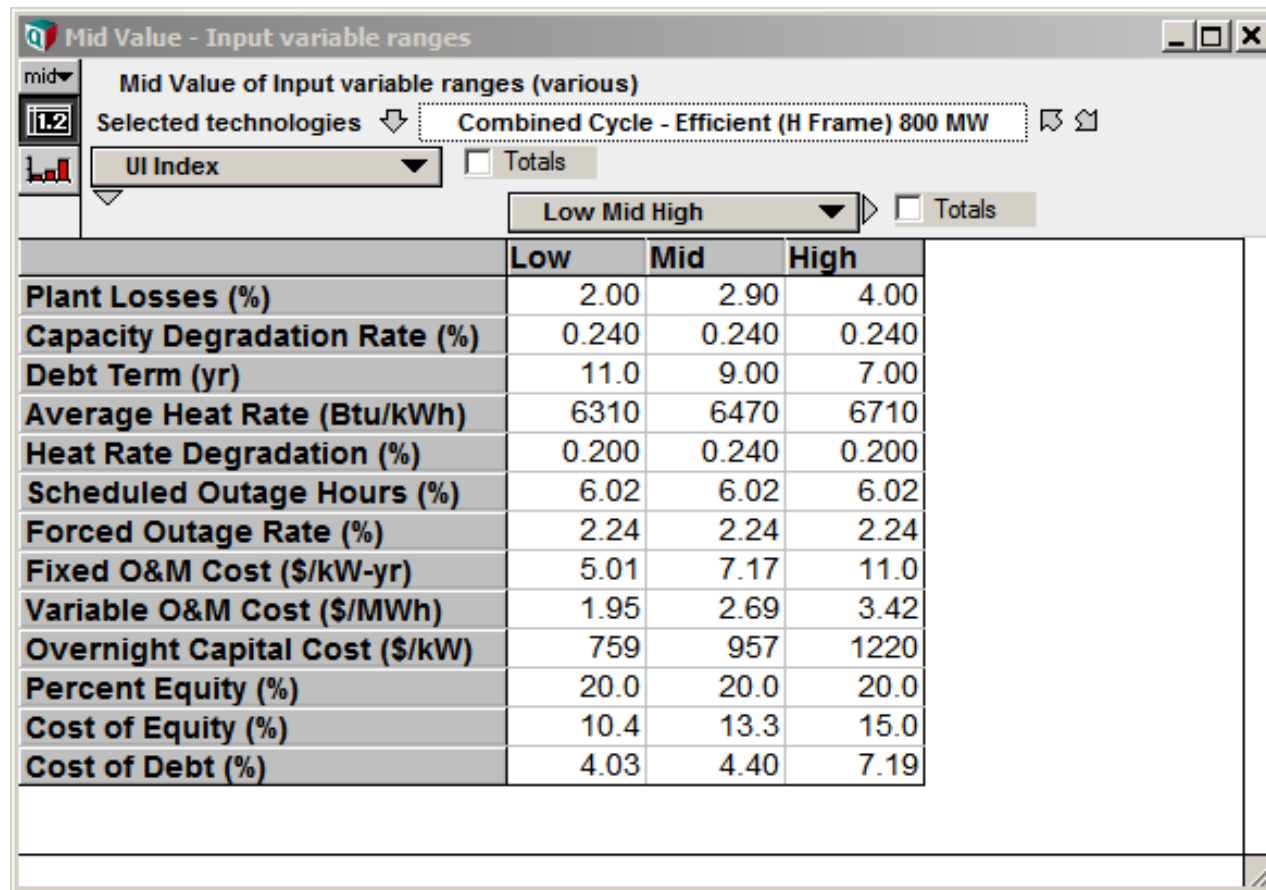
**Range sensitivity analysis:** For each uncertain input assumption, it uses COG to calculate the effect on LCOE of changing that input over its range from low to high value, while keeping all other inputs at their mid value.

**Monte Carlo simulation:** It fits a probability distribution (uniform or triangular) to the low, mid, and high values of each uncertain input assumption. It selects n random samples from the input distributions, sets the corresponding input in COG to each sample, and generates the corresponding n samples for LCOE.

For a custom set of plant types, it iterates the above over each plant type.

# Input values

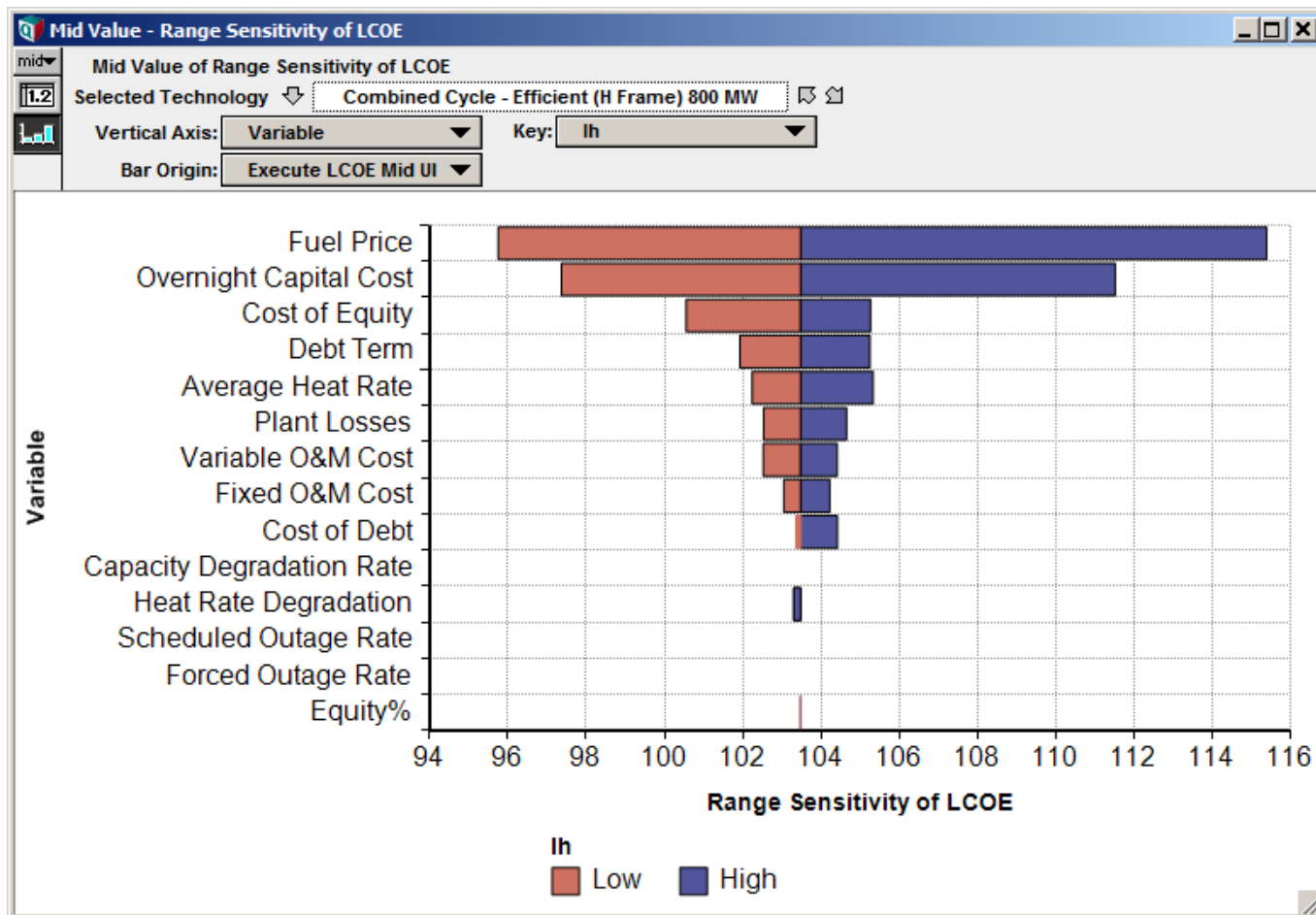
- Low, mid, and high values for each uncertain input assumption, for each Plant type.



	Low	Mid	High
Plant Losses (%)	2.00	2.90	4.00
Capacity Degradation Rate (%)	0.240	0.240	0.240
Debt Term (yr)	11.0	9.00	7.00
Average Heat Rate (Btu/kWh)	6310	6470	6710
Heat Rate Degradation (%)	0.200	0.240	0.200
Scheduled Outage Hours (%)	6.02	6.02	6.02
Forced Outage Rate (%)	2.24	2.24	2.24
Fixed O&M Cost (\$/kW-yr)	5.01	7.17	11.0
Variable O&M Cost (\$/MWh)	1.95	2.69	3.42
Overnight Capital Cost (\$/kW)	759	957	1220
Percent Equity (%)	20.0	20.0	20.0
Cost of Equity (%)	10.4	13.3	15.0
Cost of Debt (%)	4.03	4.40	7.19

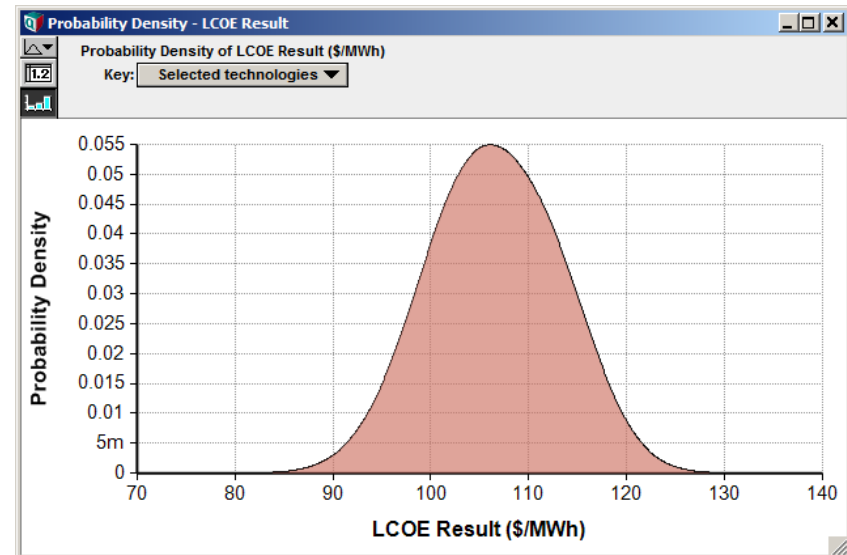
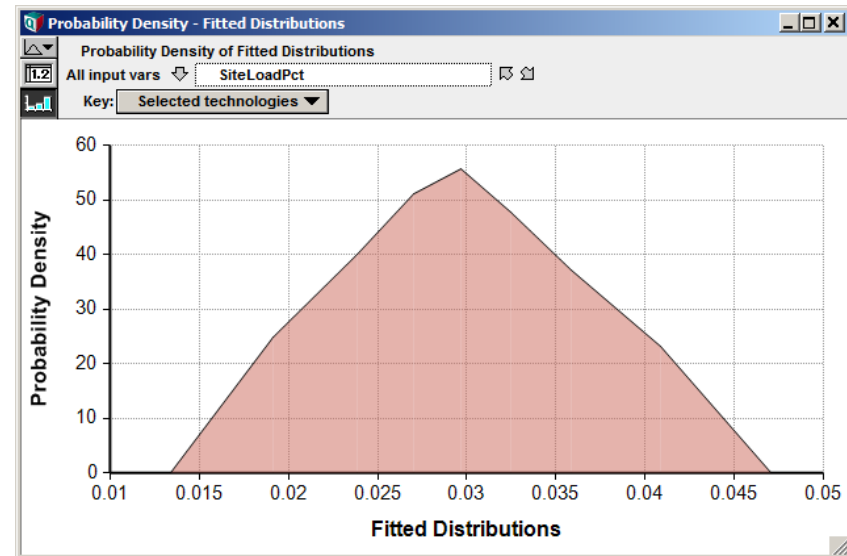
# Range sensitivity analysis

- For each uncertain input assumption, it uses COG to calculate the effect on LCOE of changing that input over its range from low to high value, while keeping all other inputs at their mid value.



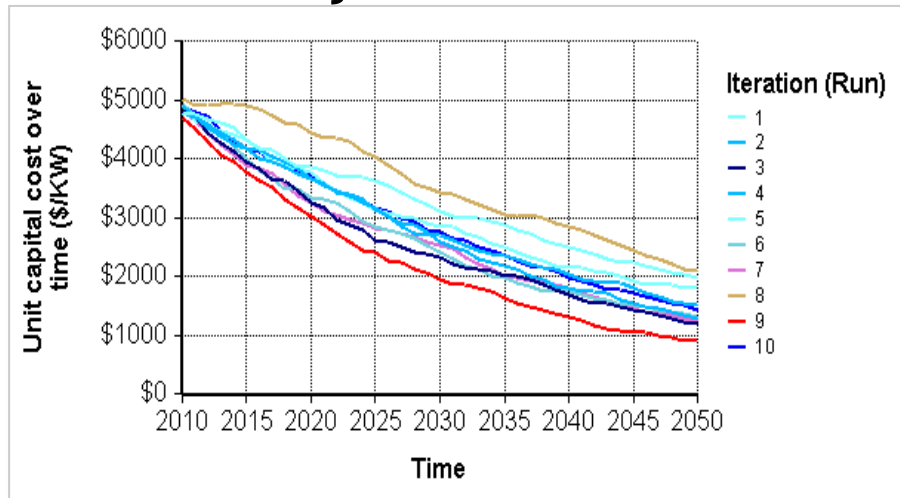
# Monte Carlo simulation

- It fits a probability distribution (uniform or triangular) to the low, mid, and high values of each uncertain input assumption.
- It treats low and high as 10<sup>th</sup> percentile and 90<sup>th</sup> percentile of distributions.
- It truncates distributions at specified minimum (usually zero) and maximum.
- It selects n random samples from each input distributions.
- For each of the n samples, it sets the corresponding inputs in COG, and calculates the corresponding results LCOE.
- It estimates the corresponding distribution for LCOE.

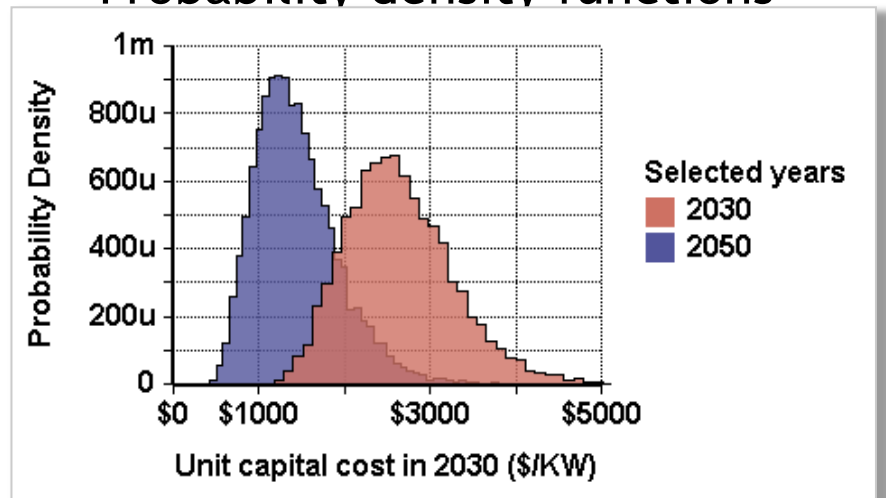


# Ways to visualize uncertainty

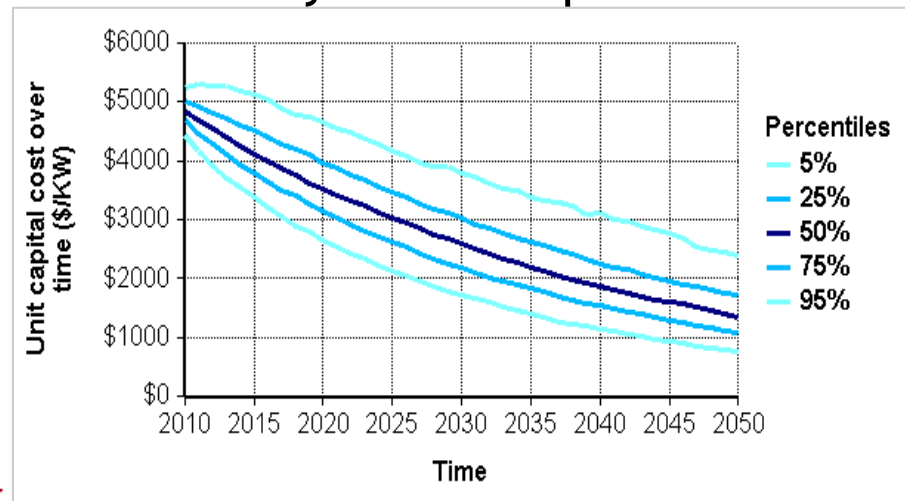
## 10 cost trajectories drawn from



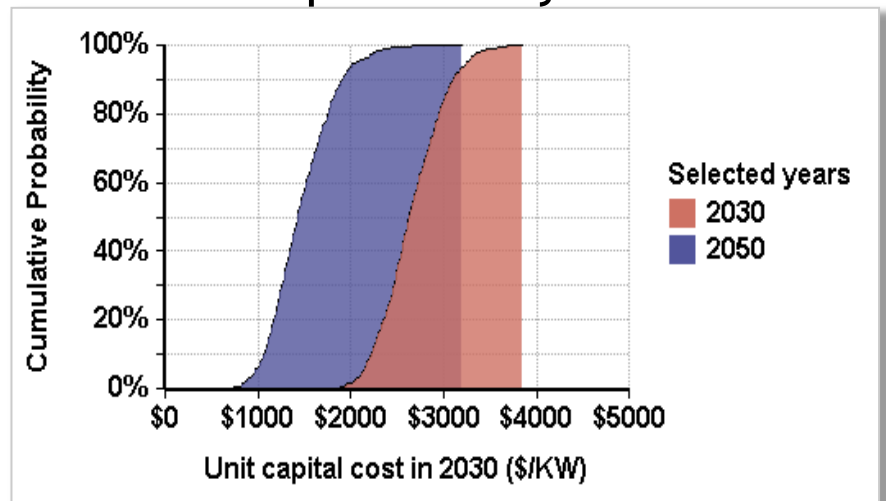
## Probability density functions



## Probability bands or percentiles



## Cumulative probability distributions



# ACAT User Interface

**Diagram - Analytica COG Analysis Tool**  
Analytica COG Analysis Tool ▶

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**Analytica COG Analysis Tool (ACAT)**  
Range sensitivity and uncertainty analysis on CEC cost of generation (COG) spreadsheet

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**Set Options**

Plant type **Combined Cycle - Efficient (H Frame) 800 MW** ▼

Custom Set of Plant Types **Edit Table**

Ownership types **SubTable**

Natural Gas Price Forecast **SubTable**

Tax loss **Tax Minimum Equals Zero** ▼

Check inputs

Input variable ranges (various) **Calc** mid **Calc** mid

Fuel Price Forecasts (\$/MMBTu) **Result** mid **Calc** mid

Output: LCOE (\$/MWh) **Calc** mid

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**Select spreadsheets**

**COG** CEC\_COG\_Model\_Version\_3\_25\_12-18-12\_... mid

**Results** ACAT\_COG\_Results\_12182012.xlsx mid

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**Spreadsheet Saving**

**COG spreadsheet import/export** ↔ **Range Sensitivity Analysis** → **COG Monte Carlo Analysis**

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**Range Sensitivity**

**Run**

Range Sensitivity of LCOE **Result** mid

Notes

**Save to worksheet** **Results 1** ▼

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**Monte Carlo**

Distribution Shape **Triangular** ▼

Fitted Distributions **Result** mid

Set Sample Size **20** ▼

**Run**

LCOE Result (\$/MWh) **Result** mid

LCOE Box Plot (\$/MWh) **Result** mid

LCOE Importance **Result** mid

Notes

**Save to worksheet** **Results 2** ▼

Modeler Name

# Architecture

## ACAT Analytica model

**Analytica COG Analysis Tool (ACAT)**  
Range sensitivity and uncertainty analysis on CEC cost of generation (COG) spreadsheet

**Set Options**

Plant type: **Combined Cycle - Efficient (H Frame) 800 MW**

Custom Set of Plant Types: **Edit Table**

Ownership types: **SubTable**

Natural Gas Price Forecast: **SubTable**

Tax loss: **Tax Minimum Equals Zero**

Input variable ranges: (various) **Calc** mid **Calc** mid

Fuel Price Forecasts: (\$/MMBTU) **Result** mid **Calc** mid

Output: LCOE (\$/MWh) **Calc** mid

**Select spreadsheets**

COG: CEC\_COG\_Model\_Version\_3\_25\_12-18-12\_... mid

Results: ACAT\_COG\_Results\_12182012.xlsx mid

**Spreadsheet Saving**

COG spreadsheet import/export

Range Sensitivity Analysis

COG Monte Carlo Analysis

**Range Sensitivity**

Run

Range Sensitivity of LCOE **Result** mid

Notes: **Save to worksheet** **Results 1**

**Monte Carlo**

Distribution Shape: **Triangular**

Fitted Distributions: **Result** mid

Set Sample Size: **20**

Run

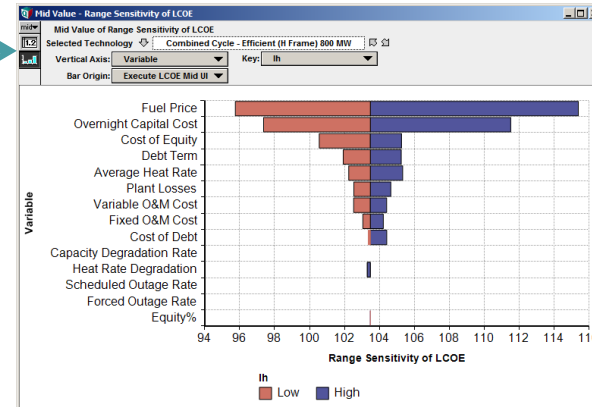
LCOE Result (\$/MWh) **Result** mid

LCOE Box Plot (\$/MWh) **Result** mid

LCOE Importance: **Result** mid

Notes: **Save to worksheet** **Results 2**

Modeler Name: **Save to worksheet**



## COG spreadsheet

	A	B	C	D	E
1	<b>Cost Of Generation</b>				
2	Plant type	<b>Wind-Class 3 50MW</b>			
3	<b>Input assumptions</b>			<b>Output result</b>	
4	Plant losses (%)		15	Levelized cost of electricity (\$/KWh)	0.18
5	Debt Term (yr)		13		
6	Average Heat Rate (Btu/kWh)		130		
7	Overnight Capital Cost (\$/kW)		1800		
8					

## Results spreadsheet

